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(71)Applicant : SHOWA DENKO KK
SHOWA HIGHPOLYMER CO LTD
(72)Inventor : IINO TADASHI
IMAIZUMI MITSUHIRO
FUJIHIRA RYUTARO
ENDO MAKOTO
MATSUI FUMIO
HATANO YOSHITAKA

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(54) CURABLE RESIN COMPOSITION EXCELLENT IN ELECTROCONDUCTIVITY AND CURED PRODUCT THEREOF

(57)Abstract:
PROBLEM TO BE SOLVED: To obtain a curable resin composition excellent in heat dissipation properties, heat resistance and corrosion resistance in addition to having high electroconductivity and especially suitable for a high electroconductive material such as a separator for a fuel cell and a cured product thereof.
SOLUTION: This curable resin composition excellent in electroconductivity and the cured material thereof comprise (A) a vinyl ester resin, (B) at least one kind of monomer selected from an allylic ester monomer, an acrylic ester monomer and a methacrylic ester monomer, (C) a radical polymerization initiator and (D) at least 40 mass % of a carbon-based filler.

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CLAIMS

[Claim(s)]
[Claim 1] (A) at least one sort of monomers and (C) radical polymerization initiator list which were chosen from the group which consists of vinyl ester resin, (B) allyl ester monomer, an acrylic ester monomer, and a methacrylic ester monomer -- (D) -- the hardenability resin constituent excellent in the conductivity which consists of a carbon system filler of 40 mass % at least.
[Claim 2] (A) Component Three to 50 mass %, (B) component 0.5 to 40 mass %, (C) component It is the (D) component to a 0.05 - 10 mass % list. Hardenability resin constituent excellent in the conductivity according to claim 1 which consists of 40 to 95 mass %.
[Claim 3] (A) The hardenability resin constituent excellent in the conductivity according to claim 1 or 2 to which vinyl ester resin is characterized by being novolak system vinyl ester resin.
[Claim 4] (B) The hardenability resin constituent excellent in the conductivity according to claim 1 or 2 to which a component is characterized by being diallyl phthalate.
[Claim 5] (C) The hardenability resin constituent the radical polymerization initiator excelled [constituent] in the conductivity according to claim 1 or 2 characterized by being organic peroxide or a photopolymerization initiator, and (D) carbon system filler being mainly a graphite.
[Claim 6] (D) The hardenability resin constituent the carbon system filler mainly excelled [constituent] in the conductivity according to claim 1 or 2 characterized by being the graphite whose aspect ratio is five or less and, whose mean particle diameter is 5-100 micrometers.
[Claim 7] (D) A carbon system filler is [an aspect ratio] mainly five or less. In the graphite list whose mean particle diameter is 5-100 micrometers, at most 40 mass % in (D) carbon system filler A gaseous-phase method [the diameter of fiber is 0.05-10 micrometers, and fiber length is 1 micrometer - 5mm] carbon fiber, and/ Or the hardenability resin constituent excellent in the conductivity according to claim 1 to 6 characterized by for the diameter of fiber being 0.005-5 micrometers, and being the carbon nanotube whose fiber length is 1-100 micrometers.
[Claim 8] The conductive hardening object which hardens the hardenability resin constituent of a publication in any 1 term of claims 1-7, and is acquired.
[Claim 9] The conductive hardening object according to claim 8 characterized by volume resistivity being below 1.0-ohmcm.
[Claim 10] The conductive hardening object according to claim 8 characterized by thermal conductivity being 1.0 or more W/m-K.
[Claim 11] The separator for fuel cells characterized by for the volume resistivity obtained from a conductive hardening object according to claim 9 or 10 being below 5x10-2ohmcm, and permeability being below 1x10-5cm2/sec.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]
[Field of the Invention] This invention relates to the hardenability resin constituent which was excellent in heat dissipation nature and thermal resistance, and corrosion resistance in addition to conductivity, and its hardening object in more detail about a hardenability resin constituent.
[0002]
[Description of the Prior Art] Technological innovation including the electronics industry in recent years has a remarkable thing, and the ingredient technique supporting this has also accomplished the rapid advance. Similarly, also about development of polymeric materials, a large number development of the polymeric materials of new or high performance is newly carried out, and the application is expected.
[0003] In the electronics field, the various engineering plastics represented by the thermosetting resin which considers as the resin with which they are a moldability, thermal resistance, endurance, electrical properties (high insulation, high conductivity, etc.), corrosion resistance, heat dissipation nature, etc. although the main properties for which polymeric materials are asked vary with a product or an application, and they fill these demands once, for example, is represented by an epoxy resin, phenol resin, etc., polyimide, a polycarbonate, polyphenylene oxide, a liquid crystal polymer, etc. are used.
[0004] By the way, although the request to the ingredient which possesses synthetically various engine performance which was enumerated above also has a thing strong of course, there is also a technical very difficult side face, and it becomes disadvantageous also in respect of a price in many cases. Development of the polymeric materials which high conductivity is in one of such the technical technical problems, and combine heat dissipation nature and thermal resistance, and corrosion resistance is mentioned, and this point also has the ingredient development made into the purpose of this invention.
[0005] Many examination has accomplished the high conductivity material which consists of a carbon system filler and thermosetting resin in the past. For example, although the combination of a graphite and phenol resin is indicated by JP,50-11355,B and JP,59-213610,A, when phenol resin is used, at the time of hardening, a low-molecular object serves as gas, it separates the setting time at the time of manufacture is long and a problem is not only in productivity, but, and a property target — a bubble may be generated in mold goods — also has a problem in the electronics field.
[0006] On the other hand, when an unsaturated polyester resin is used as base resin, it not only has the essential problem of being inferior to alkali resistance, but the pressure cooker-proof trial (durability test in the saturated steam in 121 degrees C and two atmospheric pressures) has the fault.
[0007]
[Problem(s) to be Solved by the Invention] The purpose of this invention is to offer the hardenability resin constituent which was excellent in conductivity and was excellent also in thermal resistance, heat dissipation nature, and corrosion resistance, and its hardening object.
[0008]
[Means for Solving the Problem] this invention persons tackle wholeheartedly development of the hardenability resin constituent in which it has the electric conductivity excellent in the hardening object in view of this situation by using vinyl ester resin and a carbon system filler as the main raw material, and thermal resistance, corrosion resistance, and heat dissipation nature are shown, and came to complete the hardenability resin constituent corresponding to the purpose of this invention.
[0009] namely, at least one sort of monomers and (C) radical polymerization initiator list which were chosen from the group which this invention becomes from (A) vinyl ester resin, (B) allyl ester monomer, an acrylic ester monomer, and a methacrylic ester monomer — (D) — the hardenability resin constituent excellent in the conductivity which consists of a carbon system filler of 40 mass % at least, and its hardening object are offered.
[0010]
[Embodiment of the Invention] What the glycidyl ether, acrylic acid, or methacrylic acid of bisphenol A is made to react, and is obtained as (A) vinyl ester resin in this invention is mentioned. As an example of the ******** vinyl ester resin for suitable, novolak mold vinyl ester resin is mentioned to this invention. This resin is manufactured considering the glycidyl ether of a novolak mold as a raw material.
[0011] As an allyl ester monomer of the (B) component in this invention, diallyl phthalate, cyclohexane dicarboxylic acid diaryl, etc. are illustrated. Diallyl phthalate is desirable also in these.
[0012] Moreover, as a concrete example of an acrylic ester (meta) monomer, phenoxy ethyl methacrylate, ISOBO nil methacrylate, benzyl methacrylate, JISHIKURO pentenyl oxy-ethyl (meta) acrylate, TORIMECHI roll pro pansy (meta) acrylate, TORIMECHI roll pro pantry (meta) acrylate, trimethylol propane tris-oxy-(meta) acrylate, pentaerythritol tetrapod (meta) acrylate, GURISERINJI (meta) acrylate, 1,6-hexanediol diacrylate, etc. can be mentioned. Furthermore, these halogenation compounds can also be used in order to give fire retardancy.
[0013] Organic peroxide, a photopolymerization initiator, etc. are mentioned as a (C) radical polymerization

initiator in this invention. In this invention, organic peroxide is more desirable. As organic peroxide, well-known things, such as dialkyl peroxide, acyl peroxide, hydroperoxide, ketone peroxide, and peroxy ester, can be used. As an example, they are benzoyl peroxide, tert-butyl peroxide-2-ethyl hexoate, 2, the 5-dimethyl -2, 5 JI (2-ethylhexanoyl) peroxyhexane, t-butyl peroxybenzoate, t-butyl hydroperoxide, a cumene hydroperoxide, and JI. Cumyl peroxide, di-t-butyl peroxide, 2, the 5-dimethyl -2, 5 dibutyl peroxyhexane, etc. are mentioned.

[0014] As a photopolymerization initiator, for example Moreover, 2 and 2-dimethoxy -1, 2 bibenzyl-1-ON, 1-hydroxy-cyclohexyl-phenyl ketone, a benzophenone, 2-methyl-1-(4-methylthio phenyl)-2-MONFORINOPUROPAN -1, 2-benzyl-2-dimethylamino -1 -(4-morpholinophenyl)- Butanone -1, 2-hydroxy - 2-methyl-1-phenyl propane-1-ON, 2, 4, and 6-trimethyl benzoyl diphenyl-phosphine oxide etc. is mentioned. The number of these radical polymerization initiators one, and they may mix and use two or more sorts. Moreover, the blending ratio of coal has desirable 0.05 - 10 mass %, and 0.1 - 5 mass % is especially suitable for it.

[0015] As a (D) carbon system filler in this invention, these two kinds and the composites beyond it, such as carbon black (KETCHIEN, acetylene, a furnace, oil furnace, etc.), an artificial graphite, natural graphites (kish graphite, decomposition graphite, etc.), a carbon fiber, a carbon staple fiber, and glassy carbon, can be used. It is desirable to use a graphite also in these. As a graphite, 2500 degrees C or more of 2700 degrees C or more of burning temperature were preferably manufactured above 2900 degrees C still more preferably, that whose mean particle diameter is 3-200 micrometers is desirable, and what has the description whose aspect ratio is five or less, and whose mean particle diameter is 5-100 micrometers further is desirable. As an aspect ratio, further 3.5 or less are desirable and 2.0 or less are especially suitable. Moreover, as mean particle diameter, a 5-80-micrometer thing is still more desirable. If it furthermore adds, a desirable example with desirable carbon black of at most 20 mass % and multicomputer system with carbon staple fibers (a MIRUDO carbon fiber, a gaseous-phase method carbon fiber, carbon nanotube, etc.) will also be considered in at most 40 mass % of the whole carbon system filler depending on an application, using a graphite as a principal component. It is desirable to use a carbon staple fiber also in these. Since kinetic property's [an electrical property or] using the carbon nanotube whose diameter of fiber is 0.05-10 micrometers, a gaseous-phase method [fiber length is 1 micrometer - 5mm] carbon fiber, and/or whose diameter of fiber are 0.005-5 micrometers as a carbon staple fiber and whose fiber length is 1-100 micrometers improves, it is still more desirable. Moreover, an artificial graphite may be used for a principal component for a natural graphite, blending in it, and may be used for it.

[0016] In addition, an aspect ratio is a ratio of the major axis of a particle, and a minor axis, and it is flat [-like], so that this is large. The minimum value of an aspect ratio is 1 and this is a ball or a spherical polyhedron. Scanning electron microscopy was used for measurement of the aspect ratio in this invention. With the scanning electron microscope, appearance photography of fine particles was performed, and the major axis and minor axis of each particle were measured about 300 particle number, and, specifically, it asked for them.

[0017] Generally, in the case of, in the case of the usual natural graphite, it is before and after 50, and the aspect ratio of a graphite is six to about 12 in the grinding article of an artificial graphite. thus -- that, and the consistency of mold goods does not go up or permeability becomes large **** -- etc. -- the case which does not become a satisfying enough thing may also come out [that the particle with it of the moldability represented by the restoration nature to vinyl ester resin and the fluidity depending on an application, a mold-goods configuration, and the conductive level for which it asks is inadequate] [a large aspect ratio and] [flat]

[0018] In order to obtain the hardenability resin constituent of this invention, it is desirable to use the mixer generally used in each above-mentioned component in the pitch fields, such as a roll, a kneader, a Banbury mixer, a Henschel mixer, and a planetary mixer, and to mix homogeneity if possible. Moreover, it may be good to add a radical polymerization initiator finally and to mix at the time of hardening, after mixing all the components except a radical polymerization initiator to homogeneity, and after mixing all the components except a radical polymerization initiator and a carbon system filler to homogeneity depending on the case, it may be good to add a radical polymerization initiator, to mix to homogeneity, to add a carbon system filler finally and to mix.

[0019] The obtained thermosetting resin constituent can be made into the configuration of powder, granulation, a pellet, a tablet, a sheet, etc., and a final forming cycle can be presented with it.

[0020] While carrying out size enlargement to a desired configuration as the shaping approach of the hardenability resin constituent of this invention using the shaping approaches generally learned, such as injection shaping, transfer molding, and press forming (**********), it can be made to harden by the radical which irradiates heating or a high energy line and a polymerization initiator generates. It is important to embrace the class of used radical polymerization initiator as conditions for heat hardening, and to select and search for optimum temperature. When mold-goods thickness is 4mm and dicumyl peroxide is used as an

example, at 150 degrees C, it unmolds, and perfect hardening can be carried out by carrying out after-cure at 170 degrees C for 1 hour. [for 3 minutes]

[0021] Moreover, the hardening process of making extent which does not interfere even if it omits after-cure by stopping in a mold for 3 minutes complete hardening is also employable at 175 degrees C, for example.

[0022] What has the property described below as a conductive hardening object of this invention is desirable. That is, below 1.0-ohmcm of volume resistivity is desirable, it is below 1.0x10-1ohmcm more preferably, and below 5x10-2ohmcm is especially used for the separator application for fuel cells suitably. 1.0 or more W/m-K is desirable, thermal conductivity is 4.0 or more W/m-K more preferably, and 7.0 or more W/m-K is especially suitable for it. Moreover, below 1x10-5cm2/sec is desirable, the permeability which is a characteristic value important as a separator for fuel cells is below 1x10-6cm2/sec more preferably, and below 1x10-7cm2/sec is especially suitable for it.

[0023] Furthermore, additives, such as UV stabilizer, an anti-oxidant, a defoaming agent, a leveling agent, a release agent, and water repellent, may be added to the hardenability resin constituent of this invention in addition to the above-mentioned additive for the purpose which improves a degree of hardness, endurance, weatherability, a water resisting property, etc.

[0024] Moreover, the hardenability resin constituent of this invention has workability good [without containing an organic solvent], and workability. This point is very worthy while importance tends to be attached to the safety to an operator, and maintenance of earth environment in recent years. Of course, in order to raise further the fabrication nature of the hardenability resin constituent of this invention, it is also possible to aim at one step of fluid improvement by addition of a solvent.

[0025] Moreover, it is also one of the descriptions which are not looked at by heat-curing resin constituents, such as a condensation reaction type epoxy resin of a conventional type, and phenol resin, that it can stabilize and save over a long period of time in ordinary temperature until it presents a processing process with the hardenability resin constituent of this invention.

[0026] the hardenability resin constituent of this invention may come to hand in ingredient , easily , and in large quantities , and be constitute , practicality be very high , and since the hardening object have properties , such as conductivity , thermal resistance , corrosion resistance , and shaping precision , it be useful for each application , such as various components , such as the electronics field , an electric product , a machine part , and a vehicle , and be a suitable example especially as a material for fuel cell separators .

[0027]

[Example] Although an example explains this invention further below at a detail, this invention is not limited to an example at all. In addition, a measuring method is shown below.

[0028] Permeability is the value measured with the temperature of 23 degrees C, and gaseous helium 1 atmospheric pressure (average of five samples).

[0029] Volume resistivity is JIS. Based on K7194, it measured with 4 deep-needle method volume resistivity measuring method. Flexural strength and a bending elastic modulus are JIS. Based on K6911, the test piece (80x10x4mm) was measured with the three-point type flexural strength measuring method on condition that span spacing of 64mm, and bending rate 2.5 mm/min. Molding shrinkage is JIS. It measured according to K6911 (hardening contraction). Specific gravity is JIS. It measured according to A law (underwater substitution method) of K7112.

[0030] thermal conductivity -- Kyoto electronic company make -- it measured using QTM-500 and evaluated in the following four steps.

A --- Seven or more W/mK good --- Less than 4-7 W/mK is good. --- Less than 1-4 W/mK is improper. --- Less than 1 W/mK [0031] Moreover, the used ingredient is shown below.

(A) As a component, it is A-1:novolak mold vinyl ester resin (RIPOKISHI SP[by Showa High Polymer Co., Ltd.]- 5070).

A-2: Novolak mold vinyl ester resin (RIPOKISHI SP[by Showa High Polymer Co., Ltd.]- 4010)

As an object for the examples of a comparison, A-3:phenol resin (BL[by Showa High Polymer Co., Ltd.]- viscosity in 274 25 degrees C 32000CPS) was used.

[0032] (B) as a component -- B-1:trimethylol propane tris oxyethylene methacrylate B-2 -- the B-4:styrene monomer was used as an object for the examples of a :benzyl methacrylate B-3:diaryl terephthalate comparison.

[0033] (C) As a component, he is Park Mill D by C-1:Nippon Oil & Fats Co., Ltd. (dicumyl peroxide).

C-2: Par butyl Z by Nippon Oil & Fats Co., Ltd. (t-butyl peroxybenzoate)

As an object for the examples of a comparison, 25% water solution of a C-3:sodium hydroxide was used.

[0034] (D) As a component, the grinder atomizer (Fuji Paudal, Inc. make) ground the artificial graphite by D-1:Showa Denko K.K., and further, after grinding with the Malmo riser (company make), the following graphite powder which classified was used.

average aspect ratio: -- 2.8 mean-particle-diameter: -- 80-micrometer fixed-carbon: -- the following

graphite powder which classified the artificial-graphite powder by 99.8%D-2:Showa Denko K.K. in the rough raw material after [D-1] grinding using a grinder and a grinding machine similarly was used.
[0035] average aspect ratio: — 3.7 mean-particle-diameter: — 10-micrometer fixed-carbon: — artificial-graphite powder average aspect ratio [by 99.8%D-3:Showa Denko K.K.]: -- 3.8 mean-particle-diameter: — 50-micrometer fixed-carbon: -- 99.9% — diameter of gaseous-phase method carbon fiber fiber by D-4:Showa Denko K.K.: — 0.1-0.5 micrometers fiber length: -- 1-100 micrometers [0036] It blended kneading each component shown in one or less example for 45 minutes at 40 degrees C using a kneader, and the resin constituent was obtained. Also after saving the obtained resin constituent for three months at 23 degrees C, change was not looked at by the description but it was excellent in preservation stability.
A-2 resin 77 mass sections (12.8 mass %)
B-1 monomer 23 mass sections (3.8 mass %)
C-2 initiator The 1.5 mass sections (0.3 mass %)
D-1 graphite The 500 mass sections (83.1 mass %)
In addition, 0.05 mass section addition of the hydroquinone was carried out as polymerization inhibitor to the total amount of a resin constituent. This publication is omitted in the following explanation. By the compression-molding in a plane, pressurization heating is carried out for 5 minutes, the obtained resin constituent was stiffened at 150 degrees C, and the resin plate with a thickness of 3mm was fabricated. Hardening contraction at this time was 0.165%. Moreover, the various physical-properties values which produced and measured the piece of a resin plate blank test are shown below.
Specific gravity: 2.02 (-)
Volume resistivity: 4momegacm flexural strength: 28MPa bending elastic modulus: 11500MPa thermal conductivity: Sheet metal with the maximum thickness of 2.0mm shown in an A pan at drawing 1 , a minimum thickness [of 1.0mm], and a channel depth of 1.0mm was made as an experiment. Hardening conditions are for 5 minutes at 150 degrees C, and after-cure was not performed. The sheet metal obtained here has the following properties, and had satisfied enough the property required of the separator for fuel cells.
Specific gravity: 2.00 (-)
volume resistivity: — 5momegacm permeability: — 1x10-8 — cm2/sec [0037] Each component shown in two or less example was mixed like the example 1, and the resin constituent was obtained. Also after saving the obtained resin constituent for three months at 23 degrees C, change was not looked at by the description but it was excellent in preservation stability.
A-2 resin 77 mass sections (12.8 mass %)
B-1 monomer 23 mass sections (3.8 mass %)
C-2 initiator The 1.5 mass sections (0.3 mass %)
D-2 graphite The 500 mass sections (83.1 mass %)
Next, the obtained resin constituent was stiffened like the example 1, and the resin plate was fabricated. Hardening contraction at this time was 0.160%. Moreover, the various physical-properties values which produced and measured the piece of a resin plate blank test are shown below.
Specific gravity: 2.01 (-)
Volume resistivity: 6momegacm flexural strength: 34MPa bending elastic modulus: 12000MPa thermal conductivity: The same sheet metal as an example 1 is made to an A pan as an experiment, and the result of having measured the property is shown in it below. The property required of the separator for fuel cells was satisfied enough.
Specific gravity: 2.00 (-)
volume resistivity: — 7momegacm permeability: — 2x10-8 — cm2/sec [0038] Using the omnipotent mixing agitator of the device in which an example 3 stirring aerofoil rotates and revolves around the sun, each component shown below was mixed for 45 minutes, minding and carrying out high-speed stirring (300rpm) so that the condition of fine particles may always be maintained at 40 degrees C, and the granularity compound resin constituent was obtained. Also after saving the obtained resin constituent for three months at 23 degrees C, change was not looked at by the description but preservation stability was enough. .
A-2 resin 77 mass sections (12.8 mass %)
B-1 monomer 23 mass sections (3.8 mass %)
C-2 initiator The 1.5 mass sections (0.3 mass %)
D-1 graphite The 500 mass sections (83.1 mass %)
Next, it was made to harden like an example 1 and the resin plate was fabricated. Hardening contraction at this time was 0.166%. Moreover, the various physical-properties values which produced and measured the piece of a resin plate blank test are shown below.
Specific gravity: 2.00 (-)
Volume resistivity: 6momegacm flexural strength: 26MPa bending elastic modulus: 10000MPa thermal conductivity: To the A pan, sheet metal was made as an experiment like the example 1. The obtained sheet

metal has the following properties and had satisfied enough the property required of the separator for fuel cells.
Specific gravity: 2.00 (-)
volume resistivity: — 6momegacm permeability: — 3x10-8 — cm2/sec [0039] The resin constituent was obtained for each component shown in four or less example like the example 1. Also after saving the obtained resin constituent for three months at 23 degrees C, change was not looked at by the description but it was excellent in preservation stability.
A-2 resin 77 mass sections (9.6 mass %)
B-1 monomer 23 mass sections (2.9 mass %)
C-2 initiator The 1.5 mass sections (0.2 mass %)
D-1 graphite The 700 mass sections (87.3 mass %)
Next, it was made to harden like an example 1 and the resin plate was fabricated. Hardening contraction at this time was 0.100%. Moreover, the various physical-properties values which produced and measured the piece of a resin plate blank test are shown below.
Specific gravity: 2.06 (-)
Volume resistivity: 2momegacm flexural strength: 30MPa bending elastic modulus: 12000MPa thermal conductivity: To the A pan, sheet metal was made as an experiment like the example 1. The obtained sheet metal had satisfied enough the property which has the following properties and is required of the separator for fuel cells.
Specific gravity: 2.04 (-)
volume resistivity: — 3momegacm permeability: — 1x10-8 — cm2/sec [0040] The resin constituent was obtained for each component shown in five or less example like the example 1. Also after saving the obtained resin constituent for three months at 23 degrees C, change was not looked at by the description but it was excellent in preservation stability.
A-2 resin 77 mass sections (19.2 mass %)
B-1 monomer 23 mass sections (5.7 mass %)
C-2 initiator The 1.5 mass sections (0.4 mass %)
D-1 graphite The 300 mass sections (74.7 mass %)
Next, it was made to harden like an example 1 and the resin plate was fabricated. Hardening contraction at this time was 0.412%. Moreover, the various physical-properties values which produced and measured the piece of a resin plate blank test are shown below.
Specific gravity: 1.94 (-)
Volume resistivity: 10momegacm flexural strength: 28MPa bending elastic modulus: 9000MPa thermal conductivity: To the A pan, sheet metal was made as an experiment like the example 1 except having set hardening conditions as for 2 minutes at 140 degrees C. The obtained sheet metal has the following properties and had satisfied enough the property required of the separator for fuel cells.
Specific gravity: 1.92 (-)
volume resistivity: — 12momegacm permeability: — 1x10-9 — cm2/sec [0041] The resin constituent was obtained for each component shown in six or less example like the example 1. Also after saving the obtained resin constituent for three months at 23 degrees C, change was not looked at by the description but it was excellent in preservation stability.
A-1 resin 77 mass sections (12.8 mass %)
B-2 monomer 23 mass sections (3.8 mass %)
C-1 initiator The 1.5 mass sections (0.3 mass %)
D-1 graphite The 500 mass sections (83.1 mass %)
Next, except having set hardening conditions as for 3 minutes at 170 degrees C, it was made to harden like an example 1 and the resin plate was fabricated. Hardening contraction at this time was 0.170%. Moreover, the various physical-properties values which produced and measured the piece of a resin plate blank test are shown below.
Specific gravity: 2.03 (-)
Volume resistivity: 4momegacm flexural strength: 31MPa bending elastic modulus: 13000MPa thermal conductivity: To the A pan, sheet metal was made as an experiment like the example 1 except having set hardening conditions as for 4 minutes at 170 degrees C. The obtained sheet metal has the following properties and had satisfied enough the property required of the separator for fuel cells.
Specific gravity: 2.01 (-)
volume resistivity: — 5momegacm permeability: — 2x10-8 — cm2/sec [0042] The resin constituent was obtained for each component shown in seven or less example like the example 1. Also after saving for three months at 23 degrees C, change was not looked at by the description, but the obtained resin constituent was excellent in preservation stability.

A-1 resin 77 mass sections (12.8 mass %)
B-3 monomer 23 mass sections (3.8 mass %)
C-1 initiator The 1.5 mass sections (0.3 mass %)
D-1 graphite The 500 mass sections (83.1 mass %)
Next, except having set hardening conditions as for 5 minutes at 160 degrees C, it was made to harden like an example 1 and the resin plate was fabricated. Hardening contraction at this time was 0.171%. Moreover, the various physical-properties values which produced and measured the piece of a resin plate blank test are shown below.
Specific gravity: 2.04 (-)
Volume resistivity: 3momegacm flexural strength: 29MPa bending elastic modulus: 13000MPa thermal conductivity: To the A pan, sheet metal was made as an experiment like the example 1 except having set hardening conditions as for 5 minutes at 120 degrees C. The obtained sheet metal has the following properties and had satisfied enough the property required of the separator for fuel cells.
Specific gravity: 2.02 (-)
Volume resistivity: 5momegacm permeability: 9x10-9cm2/sec[0043] The resin constituent was obtained for each component shown in eight or less example like the example 1. Also after saving for three months at 23 degrees C, change was not looked at by the description, but the obtained resin constituent was excellent in preservation stability.
A-2 resin 77 mass sections (12.8 mass %)
B-1 monomer 23 mass sections (3.8 mass %)
C-2 initiator The 1.5 mass sections (0.3 mass %)
D-1 graphite The 150 mass sections (24.9 mass %)
D-2 graphite The 200 mass sections (33.3 mass %)
D-3 graphite The 150 mass sections (24.9 mass %)
Next, it was made to harden like an example 1 and the resin plate was fabricated. Hardening contraction at this time was 0.164%. Moreover, the various physical-properties values which produced and measured the piece of a resin plate blank test are shown below.
Specific gravity: 2.03 (-)
Volume resistivity: 4momegacm flexural strength: 31MPa bending elastic modulus: 13000MPa thermal conductivity: To the A pan, sheet metal was made as an experiment like the example 1 except having set hardening conditions as for 3 minutes at 160 degrees C. The obtained sheet metal has the following properties and had satisfied enough the property required of the separator for fuel cells.
Specific gravity: 2.01 (-)
volume resistivity: -- 5momegacm permeability: -- 2x10-10 -- cm2/sec [0044] Each component shown in nine or less example was mixed like the example 1, and the resin constituent was obtained. Also after saving the obtained resin constituent for three months at 23 degrees C, change was not looked at by the description but it was excellent in preservation stability.
A-2 resin 77 mass sections (12.8 mass %)
B-1 monomer 23 mass sections (3.8 mass %)
C-2 initiator The 1.5 mass sections (0.3 mass %)
D-1 graphite The 450 mass sections (74.79 mass %)
D-4 carbon staple fiber 50 mass sections (8.31 mass %)
Next, the obtained resin constituent was stiffened like the example 1, and the resin plate was fabricated. Hardening contraction at this time was 0.10%. Moreover, the piece of a resin plate blank test is produced, and the measured various physical-properties values are shown below.
Specific gravity: 2.02 (-)
volume resistivity: -- 3momegacm flexural strength: -- 40MPa bending elastic-modulus: -- 16000MPa thermal conductivity: -- the same sheet metal as an example 1 is made to an A pan as an experiment, and the result of having measured the property is shown in it below. The property required of the separator for fuel cells was satisfied enough.
Specific gravity: 2.00 (-)
volume resistivity: -- 5momegacm permeability: -- 2x10-8 -- cm2/sec [0045] The resin constituent was obtained like each component example 1 shown in one or less example of a comparison. The odor was intense, and **** of a monomer was intense, and the obtained resin constituent had a problem in shelf life, and was lacking in practicality. After specifically saving for two days at 5 degrees C, it was in the situation which reduction in mass is looked at and cannot use.
A-2 resin 77 mass sections (12.8 mass %)
B-4 monomer 23 mass sections (3.8 mass %)
C-2 initiator The 1.5 mass sections (0.3 mass %)

D-2 graphite The 500 mass sections (83.1 mass %)
Next, it was made to harden like an example 1 and the resin plate was fabricated. When making a hardenability constituent, at the time of compression molding, the odor was very strong and the problem was in work environment.
[0046] The resin constituent was obtained for each component shown in two or less example of a comparison like the example 1. Also after saving for three months at 23 degrees C, change was not looked at by the description, but the obtained resin constituent was excellent in preservation stability.
A-2 resin 77 mass sections (47.7 mass %)
B-1 monomer 23 mass sections (14.2 mass %)
C-2 initiator The 1.5 mass sections (0.9 mass %)
D-2 graphite 60 mass sections (37.1 mass %)
Next, it was made to harden like an example 1 and the resin plate was fabricated. Hardening contraction at this time was 1.14%. Moreover, the various physical-properties values which produced and measured the piece of a resin plate blank test are shown below.
Specific gravity: 1.47 (-)
Volume resistivity: 17-ohmcm flexural strength: 26MPa bending elastic modulus: 5200MPa permeability: 2x10-7cm2/sec thermal conductivity: An improper volume resistivity value is large, and on the other hand, since thermal conductivity is small, it is not suitable as an application ingredient of this invention.
[0047] It blended kneading each component shown in three or less example of a comparison in ordinary temperature, and the resin constituent was obtained. The obtained resin was what also blocks preservation for one month and lacks in preservation stability remarkably at 5 degrees C.
A-3 resin 77 mass sections (12.8 mass %)
B-1 monomer 23 mass sections (3.8 mass %)
C-3 The 0.4 mass sections (0.1 mass %)
D-2 graphite The 500 mass sections (83.3 mass %)
Next, except having set hardening conditions as for 60 minutes at 160 degrees C, it was made to harden like an example 1 and the resin plate was fabricated. Hardening contraction at this time was 0.313%. Moreover, the various physical-properties values which produced and measured the piece of a resin plate blank test are shown below.
Specific gravity: 1.95 (-)
Volume resistivity: 20momegacm flexural strength: 22MPa bending elastic modulus: 9500MPa thermal conductivity: To the A pan, sheet metal was made as an experiment like the example 1 except having set hardening conditions as for 60 minutes at 160 degrees C. The obtained sheet metal had the following properties.
Specific gravity: 1.90 (-)
volume resistivity: -- 34momegacm permeability: -- dispersion is large at 1x10-4-3x10-6cm2/sec.
Since permeability is bad, shaping stability is further missing, and the shelf life of a hardening constituent is bad and is applied very long by the setting time, the obtained sheet metal does not fit the application field of this invention.
[0048]
[Effect of the Invention] Since the hardening object is excellent in conductivity and excellent also in thermal resistance, heat dissipation nature, and corrosion resistance, conventionally, implementation can apply the hardenability resin constituent of this invention to various application and components, such as the ingredient of the difficult field, for example, the electronics field, an electric product, a machine part, and vehicle components, widely, and is very useful especially as a material for separators for solid fuel cells.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the top view of the sheet metal made as an experiment in the example.
[Drawing 2] It is the front view of sheet metal.

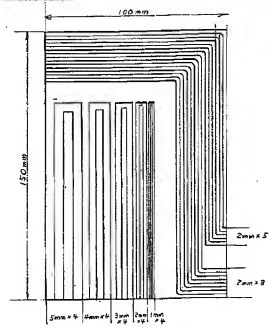
[Translation done.]

* NOTICES *

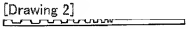
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

[Drawing 1]



[Drawing 2]



[Translation done.]